

Effects of Boric Acid Baits on Laboratory Fire Ant Colonies

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Abstract Boric acid baits killed large numbers of fire ant (*Solenopsis invicta*) workers and larvae in laboratory colonies. Queens and pupae, however, were not eliminated, and most treated colonies resumed brood production after 3-5 weeks. These results indicate that boric acid is not a suitable toxicant for large-scale or long-term control programs. Nevertheless, boric acid might be useful in combination with growth hormones or for small areas that can be retreated every few months.

Introduction

Boric acid is a well-known insect poison with relatively low toxicity to vertebrates (Linden et al. 1986). It has been used for control of Pharaoh's ants (Newton and Coombes 1987) and cockroaches. A potential advantage of boric acid for fire ant control is that it is a slow acting toxicant that could be disseminated throughout a colony by trophallaxis (communal feeding).

Several boric acid formulations have been field tested with fire ants, including mound drenches (Lemke et al. 1985) and baits (Diffie et al. 1987). Results of these tests have been disappointing. The purpose of this investigation was to test the effectiveness of various boric acid bait formulations under controlled laboratory conditions.

Materials and Methods

Laboratory tests were carried out using standardized test colonies of the fire ant, *Solenopsis invicta*. Test colonies initially contained 5 queens, 5 g of workers and 1 g of brood. These colonies were formed from a mixture of five polygyne field colonies. Field colonies were mixed to provide a large and relatively homogeneous source of workers and brood for the test colonies.

Care and handling procedures were similar to those described by Banks et al. (1981). Test colonies were maintained at 32°C and fed crickets and 1 M sugar water every other day. Poison baits were introduced about 2 wk after the test colonies were set up. Sugar water and solid food were withheld for 2 days prior to treatment.

The experiment contained a control group and four treatment groups, each with five test colonies. The first treatment group received a 1M solution of sucrose and 2% boric acid. A higher concentration of boric acid was not used because boric acid is rather insoluble in water. This solution was presented in small balls of saturated tissue paper. The second group received a solid bait formulation with 17% boric acid. This formulation was provided by Bethurum Research & Development, Inc., P. O. Box 3436 Galveston, TX 77552 under the trademark of "Bushwhacker". Besides boric acid this bait contained ground fish meal, various grains, fish oil, shrimp, preservatives, and vitamins. The third group received a 4:1 mixture of Bushwhacker™ and pulverized Logic® (batch number R6353-2). This bait contained 19% boric acid. The fourth group received the standard preparation of Logic®. Excess quantities of all baits were provided for 24 h; baits not collected during this period were removed and discarded. Several similar pilot studies were also conducted. Results were analyzed using analysis of variance. Means are shown \pm SE.

Results

Several preliminary tests were conducted to determine which concentrations of boric acid were most effective. For sugar solutions, this was about 2-4%, because higher concentrations are not soluble. For dry bait formulations (Bushwhacker), 15-20% boric acid appeared to provide maximum results; higher concentrations reduced bait palatability while lower concentrations (e.g. 5%) were much less effective. Extending the duration of access to baits for longer than 24 hr produced little benefit, probably because feeding had ceased before this time.

Results of the main experiment are shown in Figure 1. Control colonies continued to grow vigorously over the three-week period. Colonies receiving boric acid in a sugar solution declined moderately (ca. 30%) from their original size at setup, but all five had resumed vigorous worker brood production by three weeks. Both groups receiving Bushwhacker bait declined substantially in size (ca. 70%). The major difference between the two Bushwhacker treatments was that three of the five colonies receiving only Bushwhacker bait had resumed worker brood production, while none of the colonies receiving a Bushwhacker- Logic mixture contained worker brood and the few larvae were all sexualized. The Logic group of colonies showed little decline over the three week period and all remaining larvae were sexualized.

Overall, the Bushwhacker bait formulation was very attractive. In the main experiment, foragers collected 2.3 ± 0.4 g of the Bushwhacker bait compared to 0.7 ± 0.1 g of the Logic and 1.4 ± 0.1 g of the mixture. The shelf-life of this product was not tested, but bait in a once-opened container stored at 24°C remained attractive after four months. A mixture of peanut butter and 20% boric acid was also tested with four colonies in a separate experiment. Substantial worker kill resulted in two of the four colonies, but as with the Bushwhacker and sugar formulations, brood production resumed after about four weeks.

The general effects of different boric acid bait formulations on experimental colonies were quite similar: About 24 hr after feeding on these baits, workers began clustering over the brood as if the colony was severely dehydrated. This behavior continued for 2-3 days. A distinct reduction in the number brood resulted during this period and many workers began roaming about in the feeding tray. Substantial worker mortality began after about one week and continued for two or three more weeks. Queens and pupae were not killed. Pupa were not affected because they do not feed during this stage, but it remains a mystery why the queens were unaffected.

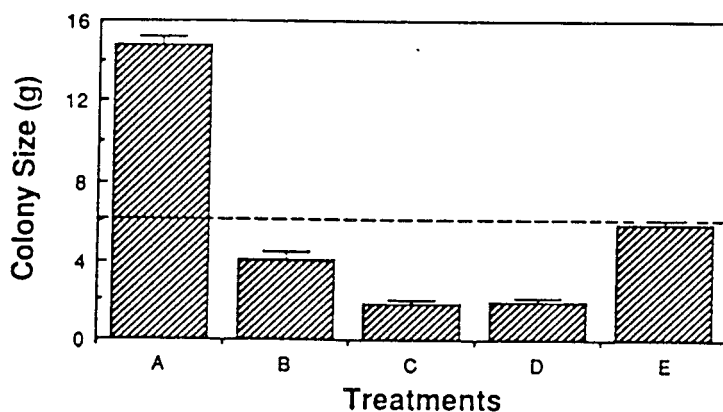


Fig. 1. Impact of boric acid baits on the size of standardized laboratory colonies three weeks after treatment. Dashed line shows initial size of colonies at set up. Treatments were as follows: A) control, B) 2% boric acid in a 1 M solution of sucrose, C) Bushwhacker™, D) Bushwhacker™ + Logic®, E) Logic®. All means were significantly different except C and D (Scheffé's F-test, $p < 0.05$).

Discussion

Boric acid baits are probably not suitable for long-term or large-scale control programs. Ingestion of boric acid eliminated brood production in test colonies for several weeks and killed a substantial portion of the workers. Unfortunately, queens were not killed and worker brood production generally resumed after 3-4 weeks. In other words, these baits severely reduced colony size, but their impact on the colony as a whole was not lethal.

Nevertheless, boric acid baits might be useful in small yards or gardens where repeat applications are practical and where other baits are not registered for use. Field tests have not been done, but it is possible that applying boric acid baits at 1-3 month intervals could provide fairly effective control even though colonies were not actually eliminated.

Another interesting possibility is a bait combination including both boric acid and a growth hormone such as Logic. This mixture appears to combine the short-term impact of boric acid (Fig. 1) with the long-term effectiveness of a growth hormone. Such a product would be most useful in yards or public parks where the 2-3 month delays associated with most growth hormone baits are unacceptable. The addition of boric acid, however, may not improve the long-term effectiveness of growth hormones; conceivably, long-term effects could even be reduced by killing off workers that would otherwise serve as a reservoir for the hormone. Field tests would be necessary to resolve the effectiveness of a combination bait and its potential limitations.

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